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Feasibility Study of Pohon Mas Restaurant Air-Conditioning System

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FEASIBILITY STUDY OF POHON MAS RESTAURANT

AIR-CONDITIONING SYSTEM

DANIEL TING MOI LEE

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing System)

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ABSTRACT

This research was done to evaluate the indoor air condition of Pohon Mas Restaurant and find out the source of problem which caused a poor indoor environment of Pohon Mas Restaurant. ASHRAE standard is chosen as standard reference when doing theoretical calculation for ideal cooling load for the restaurant and also field measurement to find out actual value.

The study found that ideal cooling load is almost three times the actual cooling load and ventilation in actual restaurant condition is only 4.6 percent of ventilation in ideal restaurant condition. Besides that, actual indoor conditions like temperature and relative humidity for restaurant are higher than ideal indoor conditions.

The study proposed installation of additional exhaust hood above food corner to exhaust smelly air out and additional exhaust fan to exhaust fresh air into restaurant. Additional air conditioning split units are install to increase the actual cooling load to meet the requirement of ideal cooling load.

ABSTRAK

Kajian ini dilakukan untuk menilai keadaan udara dalam Restoran Pohon Mas dan mencari punca masalah yang mengakibatkan kelemahan keadaan keliling Restoran Pohon Mas. Ukuran ASHRAE diguna sebagai rujukan untuk mengira ideal muatan penyejuk dan muatan penyejuk sebenar daripada peninjauan lokasi.

Kajian ini mendapati bahawa ideal muatan penyejuk adalah lebih kurang tiga kali ganda lebih daripada muatan penyejuk sebenar. Tambahan pula, kadar pertukaran udara bagi keadaan restoran adalah kurang memuaskan berbanding dengan kadar pertukaran udara dalam keadaan ideal. Selain itu, suhu dan kelembapan dalam restoran adalah lebih tinggi berbanding dengan keadaan ideal.

Kajian ini bukan sahaja mencadangkan supaya memasangkan tudung penghisap di atas tempat meletak makanan dengan tujuan menghisap keluar udara yang berbau malahan juga mencadangkan supaya pemasangan kipas penghisap tambahan dengan tujuan untuk membekalkan udara segar dalam restoran. Tambahan pula, kajian ini juga mencadangkan supaya penghawa dingin tambahan dipasangkan demi meningkatkan muatan penyejuk dalam restoran.

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CHAPTER 1

INTRODUCTION

1.0 Overview

Heating, ventilating and air conditioning (HVAC) is a system which designed to provide control of space environment. This includes temperature, humidity, air quality, air motion within a space. Most of our homes, offices and commercial facilities nowadays have install HVAC to provide human comfort whole year round. Plus, most of people spend their majority time indoor .Due to this situation, indoor-air conditions in term of thermal comfort and indoor air quality is very important. It will directly affect not only human productivity but also human health.

After the mid 1970s, public recognize and aware of domestic energy conservation in Western countries due to world wide energy crisis (McQuiston, Parker, and Spitler, 2000). Since that, HVAC design following the path of increasing the efficiency and minimize the loss of energy through building (McQuiston, Parker, and Spitler, 2000; Wang *et. al.*, 2004).

Energy conservation in buildings can be achieved through reducing the circulation between outdoor fresh air and indoor air or in other word means reduce the air exchange rate (Wang *et. al.*, 2004). The combination of low ventilation and

present of all kind sources of combination chemical lead to high concentration of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and human bioeffluents in the building (Godish, 2001). As a result, occupants easily catch an illness symptoms call sick building syndrome (SBS) (Godish, 2001).

One of the primary purposes of HVAC system is to make occupants comfort in term of thermal comfort. But, thermal comfort is a difficult task for HVAC designer because sensation of comfort is different for everyone. It is depend on level of activity, physique and clothing of individual. Besides that, some environment variable will also affect the result. For example, people who sit near the diffuser will feel cooler than people sit far from the diffuser. The diffuser must be installed at a prefect place around the building to let air flow all around the building.

This paper explores the issue of evaluating the indoor air condition of Pohon Mas Restaurant, Universiti Malaysia Sarawak (UNIMAS). Indoor air condition of a restaurant is important, it not only affecting the occupant health but also appetite.

This paper is presented in five chapters. The first chapter provides an introduction to the matter at hand. The second chapter will cover the literature review that describes the standard available, procedure and consideration when designing air conditioning system. The third chapter will describe the methodology used to obtain ideal value and actual value like cooling capacity, temperature, humidity, air motion and ventilation rate for an air conditioning system. Then the comparison is made between actual value and ideal value to find out the problem. The fourth chapter provides the findings and results of actual value and ideal value through calculation

and field measurement. Comparison between actual value and ideal value is done to find out the source of problem and the discussion is done base on the results. The fifth chapter shows the conclusion and recommendation for this study with the purpose to improve current air-conditioning system in Pohon Mas Restaurant.

1.1 Problem Statement

There have several problem faced by Pohon Mas Restaurant, UNIMAS. The main problems are smell of foods maintain in Pohon Mas Restaurant, cooling system not able to perform well in providing the comfort environment and air circulation within Pohon Mas Restaurant. These problems are discussed as follows:

a) Smell

The main problem occur in Pohon Mas Restaurant is the smelling problem. These smell problems occur due to the poor indoor air quality (IAQ) control. The smokiness of the restaurant mainly is from cooking smoke or the foods smell.

b) Cooling

During peak time, Pohon Mas Restaurant is not able to maintain it cooling condition. This situation happens because the heat release in the Pohon Mas Restaurant is over the limit capacity of the air-conditioning. The cool air produce can not decrease the temperature inside the Pohon Mas Restaurant to provide a comfort environment.

c) Air circulation

There might a problem of air circulation within Pohon Mas Restaurant. The restaurant seems stuffy. This may be due to lacking of sufficient ventilation within Pohon Mas Restaurant.

1.2 Project Objective

The main purpose of this study is to determine indoor environment condition of Pohon Mas Restaurant which with the specific objectives shown like below:

(a) Evaluate the indoor air condition of Pohon Mas Restaurant.

(b) To find out the causes of the problem due to environment, design and material use.

(c) Propose the solution to solve the problem.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Heating, Ventilating and Air-Conditioning

In the past, air conditioning refers to cooling or improving the indoor environment during summer. Nowadays, air-conditioning not only for cooling but more accurately is it designed for human comfort or industrial application (McQuiston, Parker, and Spitler, 2000). The pioneer of air conditioning, Willis Carrier is the first person who defines that air conditioning refers to the control of temperature, moisture content, cleanliness, air quality and air circulation as required by occupants, a process or a product in the space (McQuiston, Parker, and Spitler, 2000).

In very early time, human beings already know to use the evaporation effect and ice for cooling (Haines and Wilson, 2003). This is where the idea of air conditioning comes. The idea only comes to practical in the middle of nineteenth century where the first practical refrigerating machine was built (Haines and Wilson, 2003). By the end of nineteenth century, concept of central heating has reached satisfactory development.

The concept of cooling for human comfort gets its start in the early twentieth century (Haines and Wilson, 2003). On the 1902, the first prototype of air-conditioning was created by Willis Carrier (Haines and Wilson, 2003). Since that time, air conditioning is rapidly develops to HVAC what we know today.

2.2 Standard of Practice for Air-Conditioning Design

When talking about design in professional field, there are all kind of standard that have to consider and follow by the designer to make sure the items that design perform as expected. Standard is the requirement stated by an organization or government of a country to ensure products that design when come to operation will not danger the life of the user.

2.2.1 Available Standard

In air-conditioning design field, there are several standard for the designer to choose and follow. For example the British Standards (BS), Chartered Institution of Building Service Engineering (CIBSE) Standard and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard (Kreider, 2001; Porges, 1992; Chadderton, 1996). For this research, ASHRAE Standard was chosen as the primary standard because ASHRAE Standard is the most common used standard in air-conditioning design. Besides that, most of the reference books also refer to this standard.

2.2.2 Indoor Air Quality / Indoor Environment Quality

Good indoor air quality (IAQ) or indoor environment quality (IEQ) can be defined as air that is free of pollutions that will cause irritation, discomfort or ill health to occupant or decrease the duration of degradation of the building material, painting and equipment (Kreider, 2001).

As stated in ASHRAE Standard 62, acceptable indoor air quality must meet two requirements. First, concentrations of contaminants in the air must not reach harmful level as determines by cognizant authorities. Second, 80% or more people who expose to the air will not feel dissatisfaction (Godish, 2001). Mostly, contaminants within indoor space come from three sources: human and animal, furnishings and equipments or processes taking inside the space, and contaminants from outdoor air (Godish, 2001). For more detail, refer to Appendix A for principal indoor pollutants, source and typical concentrations

2.3 Design Consideration

The primary function of air-conditioning is to maintain the indoor environment as required by occupants. To perform this function, air-conditioning system with proper cooling and heating capacity must be installed and controlled throughout the year. Malaysia is located in equator zone, so, some of the design consideration like heating are not really consider in design the air-conditional system.

There are several things that must put into consideration when designing air conditioning system in Malaysia which included space characteristics and heat load

source, location of equipment and services, air conditioning load estimation, outdoor heat sources, indoor heat sources and equipment selection (Anonymous, 1972).

2.3.1 Space Characteristics and Heat Load Source

An accurate survey onto characteristics and load components of the space to be air- conditioned is the basic requirement for estimating cooling and heating load within the space (Anonymous, 1972). The information from the survey is the very foundation of the estimate and it gives the designer a guideline or basic idea about the space. Mostly the survey is done onto the architectural drawings, complete field sketches, site study and photographs of important aspects. Below is the aspect that must be considered when doing survey.

a) Orientation of the building

   Location of the space to be air conditioned with respect to sun, wind, and shading effects and reflective surface around the space (Anonymous, 1972). This will affect the amount of heat gains through conduction of exterior structure and radiation through glass.

b) Use of space

   Space to be air conditioned is build for what purpose usage (Anonymous, 1972). The standard value like temperature, humidity ratio and ventilation rate are depend on what purpose usage of the building or room.

c) Dimension of space

The height, length and width of the space will affect the cooling load capacity (Anonymous, 1972). Larger space in a building or room will need larger cooling capacity compare with the smaller space in a building or room. So, dimension of space is can not be ignorance by the researcher.

d) Construction materials

Material that use in constructing the wall, roof, ceiling, floors and partition of the space will also affect cooling load capacity (Anonymous, 1972). Different construction material will have different heat transfer coefficient value with will be applied into calculation of cooling load capacity as a standard value.

e) Surrounding conditions

Surrounding condition consists of the color of the wall and roof and the surrounding temperature for the space conditioned (Anonymous, 1972). Color of wall and roof and temperature outside the space conditioned will affect the conduction and radiation of heat from outside to conditional space. The darker the color of wall and roof, the higher the conductivity of heat to conditional space and vice versa. It is same situation for surrounding temperature.

f) Windows

Construction material of a window and its location will affect the amount of heat conduct and radiate into a building or room (Anonymous, 1972). Different construction materials of window have different transfer coefficient value. Window facing to difference direction will have difference shading coefficient

and cooling load factor. This is because different direction of window will cause a building or room expose to the different amount of heat of sunlight.

g) Doors

Location, type, size, and frequency used of the door will affect the amount of air infiltrate into condition space (Anonymous, 1972). Different construction materials for door have difference transfer coefficient value. Door facing to difference direction have difference shading coefficient and cooling load factor. Frequency of use of the door will affect value of infiltration of air into restaurant.

h) People

Number of people, duration of occupancy, and nature of activity of people in the space will affect the cooling load calculation for designing air conditioning system (Anonymous, 1972). This is because the human body temperature will cause the environment become warmer.

i) Lighting

Type of lighting and wattage will affect the cooling load calculation for lighting (Anonymous, 1972). This is because different type of light will produce different amount of heat to the surrounding. For example, fluorescent light will produce more heat than incandescent light.